A Multi-Method Exploration of Crime Hot-Spots

Spatial and Temporal Analysis of Crime (STAC)
Version 4.0

Summary of Findings

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Introduction

This paper covers the findings of an evaluation of a "hot spot" spatial analysis software package that will be presented at a workshop at the Academy of Criminal Justice Sciences (ACJS) conference in Albuquerque, New Mexico on March 11, 1998. The workshop is to cover the systematic comparison of eleven "hot spot"spatial analysis packages. Following is the summary evaluation for the STAC (Spatial and Temporal Analysis of Crime) program.

STAC was created by the Illinois Criminal Justice Information Authority (ICJIA) in 1988. It is available to users on a no-cost basis: the STAC software is free. The ICJIA requires users to sign a contract stating that copies of the software will not be sold, that the Authority will be cited in any publication or report where STAC analysis is used and that users will provide help to other STAC users through a user network.

As the acronym implies, STAC includes two methods of analysis: spatial and temporal. The spatial module (SPACE) was used in this analysis to map "hot spot" areas or highest concentrations of crime. The maximum number of cases that can be analyzed at any one time is limited to 16,000. Also packaged in the spatial module is the Nearest Neighborhood Analysis (NNA), which looks for non-random clustering of crime incidents. The NNA can calculate up to 3,000 incidents at one time. The temporal module (Time Analyzer) determines the most likely day and time a particular crime will occur.

For our evaluation, a data set containing 7,719 records of residential burglaries and street robberies for Baltimore County, Maryland were provided for the period November 1, 1996 to November 30, 1997. The data was obtained through the Regional Crime Analysis System (RCAS) and included all offenses of these types reported to the police for that specific period. The data had already been geo-coded (96.5 percent "hit" rate) for subsequent analysis. There were 123 fields in the file. For the purposes of this evaluation, MapInfo (version 4.1) was used for all map output.

STAC Algorithm

The STAC hot spot area algorithm has two steps. First, STAC conducts a search for the densest clusters of points within a given boundary. Second, STAC calculates a standard deviational ellipse for each cluster. The following describes the algorithm for finding the dense clusters as taken from the STAC Technical Manual (ICJIA, SPACE Technical Manual, 1/1/96, p. 1):

1. Depending on the user-selected scan (triangular or rectangular) a lattice grid is overlaid on the search area. Then a search for incidents is conducted. The program lays down circles with the user-defined search radius over each node of the grid.

2. The program counts the number of points that fall within each of those circles.

3. The results from step two are sent to an output file. The X and Y coordinates of the nodes that have at least two incidents within the search radius are recorded, along with the number of incidents found for each node (e.g., X coordinate =... Y coordinate= ... 15 incidents within the search radius).

4. The results are then ranked in descending order according to the number of incidents found within the search radius of the various nodes. (No more than 25 nodes are sent to file). These top 25 nodes, with their associated incidents, are stored in arrays called sets.

5. The program checks for overlapping circles. These are two or more circles that share the same incident(s). If there are any circles with overlapping record numbers, the sets are combined into bigger ones called clusters. (That is, the sets with an intersection are grouped together.)

6. For each hot spot cluster, the program calculates a standard deviational ellipse. These are called “hot spot areas.”

Data preparation

The data were provided in .dbf format which could be readily imported into a database or spreadsheet program. The file contained 7,719 records of which 96.5 percent were geocoded. In order to do this analysis the file was divided into the two offense types: burglary and robbery. After cleaning-up the file and removing the non-geocoded incidents there was a total of 7,471 incidents: 1,252 residential burglaries and 6,219 street robberies. Due to the large size of the files, each was then stripped to include only the three fields needed by STAC: ID, x-coordinate, and y-coordinate. The file was then saved in an ASCII comma-delimited format which is required by STAC.

STAC performs all of its computations utilizing flat grid Cartesian geometry. This can be the UTM (Universal Transverse Mercator) coordinate system, state/plane coordinates, or any other flat coordinate system. The data were provided in latitude/longitude format (e.g., -76.00000, 38.00000). To make the data usable for the STAC program, it must be converted to the UTM system for calculation and saved back to latitude/longitude format to import into a mapping program. If the data are already in a flat coordinate system, they do not need conversion. Once specified, the program does the conversion automatically. The unit of measurement for the UTM system is meters.

The initial set up seems a little tedious. The program lends itself to being used for one particular area. Several files must be modified before the program can be used. First, the longitudinal zone number needs to be specified. A Universal Transverse Mercator table is provided in the manual to specify the correct zone. The default is set at zone 16. The correct zone for our analysis was 18.

The second step involves setting the boundary search area. Again, since STAC uses the UTM or any flat coordinates a translation is required to get the points into the appropriate format (for example, from lat/long to UTM). A program is packaged with STAC (ZOOM) to do this conversion. It is an easy step. Once the translation program is launched at the DOS prompt the user is asked to put in the upper x- and y-coordinates and then the lower x- and y-coordinates in lat/long format. It takes those coordinates in the new format and saves them in the SPACE.PRM file.

The SPACE.PRM is the file where the user-selected parameters are saved. After ZOOM is run, it saves the lat/long boundary search coordinates in UTM format in this file. The output is contained in the first four lines of the file. The next three lines correspond with the user inputs: search radius, type of scan (triangulated or rectangular) and the minimum number of incidents the user wishes STAC to find. This file can be edited in DOS or it can be changed within the STAC program.

Once these files have been edited, the user is ready to use the STAC program. The program produces the ellipses which can then be imported into a mapping program. STAC produces boundary files (ellipses) for direct import into MapInfo, however it does not save the boundary in any other mapping format. The manual provides further information on importing those ellipse boundary files into Atlas GIS, but makes no mention of ArcView. ICJIA states that users have created an Arcview script to automate the import function (Dan Higgins, personal communication, 1998).

Using the STAC Program

STAC allows three user-defined parameters in addition to the boundary search area: search radius (in meters), scan type (triangulated or rectangular) and minimum number of incidents to be included in each cluster. These can be done through the DOS menu system. There is also an initial set up screen where various parameters can be entered.

As mentioned earlier the search area boundary must be established. This can be done either by editing the parameter file (SPACE.PRM) or through the spatial analysis menu. The boundary consists of the following four pieces of information: the lower left x-coordinate, lower left y-coordinate, upper right x-coordinate, and upper right y-coordinate. These four numbers make up the first four lines in the parameter file.

The search radius specified is the element that sets the size and spacing of the lattice grid and the radius of the overlapping circles when determining hot spot clusters. If this radius is set too large for a particular area it may give just one cluster. On the other hand if it is set too low many clusters may be found. Whatever radius is chosen it is important to remember that it should vary with the search area. The output depends on how intelligently the users determines the search radius. In our analysis we randomly selected five points and averaged the number of incidents found in each of the three radii: 500, 1,000, and 3,000 meters.

STAC allows for two types of scan options: triangular and rectangular. The program defaults to the more compact triangular scan. If the user is working in an area with a grid street system, the rectangular scan may be more useful. The manual recommends that the user experiment with both types.

In our analysis, after running STAC with both scan types and generalizing that there were no significant differences between either method, we produced all subsequent maps using the triangular scan. The street systems in Baltimore County are more curvilinear, not grid.

Face Validity of Hot Spots

A series of maps were printed using the base data. "Pin" maps were produced using the x- and y-coordinate points for each type of offense. See Maps 1 and 5. From this map, graduated circles were produced which indicate the number of incidences occurring at each particular address (lat/long coordinate). See Maps 2 and 6.

To estimate a baseline measure for the minimum number of incident parameter needed by STAC to define the hot spots, five points were randomly selected from within the county. At each point and for each offense type, a radius was selected for 500 meters, 1,000 meters, and 3,000 meters. The points falling within each radius were counted and then averaged to give the minimum number incidents for STAC to include within an ellipse.

STAC Output

The following tables detail the number of hot spot areas found using the specified user-input parameters. The data are presented first for residential burglary at the county level, then for the southwest portion of the county. The second series represents the output for street robberies at the county level then the southwest portion of the county.

RESIDENTIAL BURGLARY DATA

The average number of residential burglary incidents during the study period by radius size appears in Table 1.

Table 1
Average number of burglary incidents
(N=1,252)

	Radius	Average # of Incidents
a.	3,000 meters	181
b.	1,000 meters	24
c.	500 meters	5

Using the average number of incidents as the required minimum was thought to be the most parsimonious way of selecting the minimum number of incidents in a cluster for a standard deviational ellipse to be calculated for both types of offenses.

"Pin" Maps of Residential Burglary Data

In the display of point data for residential burglaries a pattern emerges. It appears that several arterials have a clustering of points: Liberty Road, Reisterstown Road, York Road, Belair Road, and Essex Road. These groupings appear to form a spoke radiating outward from the city/county boundaries. See Map 1.

Graduated Circle Maps of Residential Burglary Data

The number of incidents at one location ranged from one to sixteen. After producing graduated circles to depict multiple incidents occurring at one location there appear to be ten clusters. See Map 2.

Moving in a clockwise pattern starting at the southwest portion of the county the clusters were located in the following areas:

1. The area around Harbor Tunnel Highway and Baltimore Washington Pkwy (Rt 295)
2. Baltimore National Pike (Rt 40 W) between I-695 and the county boundary (approx. Charing Cross Road).
3. Liberty Road & Route 26
4. A cluster appears at the very northern part of the county, however, upon further examination there were eight reports with the same report number. The location was York Road near Old Harris Mill.
5. York Road and E. Timonium Road
6. I-695 and Dulaney Valley Road
7. York Road and Stevenson Lane
8. Near the intersection of Whitemarsh Blvd & Honeygo Blvd.
9. Franklin Square Drive and Lennings Avenue
10. Pulaski Highway & Middle River Drive

Baltimore County

A. Using the 3,000 meter radius and a minimum number of 181 incidents per cluster STAC produced two ellipses for the county using the residential burglary data. Since STAC did not find any cluster with 181 or fewer incidents, the setting of "minimum number" did not affect the results. See Map 3.

Cluster Number	Number of Events in Cluster	Number of Events in Ellipse	Events per One Million Sq. Meters
1	2,669	2,773	8.393
2	1,926	1,822	10.818

Event density outside of all ellipses = 0.490/1 million square meters.

Both areas center along I-695 and I-70 on either side of the county.

B. Nine hot clusters were produced for the burglary data when the search radius was reduced to 1,000 meters and the minimum number of incidents was 24. Since STAC did not find any cluster with 24 or fewer incidents, the setting of "minimum number" did not affect the results. See Map 4.

Cluster Number	Number of Events In Cluster	Number of Events In Ellipse	Events per One Million Sq. Meters
1	356	407	25.198
2	319	379	17.426
3	239	218	33.792
4	147	140	25.453
5	127	119	25.194
6	87	88	26.484
7	86	88	33.651
8	84	86	39.395
9	79	82	24.941

Event density outside of all ellipses = 0.490/1 million square meters.

The nine hot spot areas were found at the following locations:

1. Intersection Southeast Blvd. & Eastern Blvd.
2. Along I-695 from approximately Southwestern Blvd to I-895.
3. Intersection of Peninsula Expressway and Sollers Point Road
4. Along Baltimore Pike from Ingleside Avenue to past county boundary.
5. Intersection of Taylor Avenue and Loch Raven Road
6. Intersection of Merritt Blvd & Wise Avenue
7. Centered on Dulaney Valley Road from E. Burke Avenue to North of Fairmont Avenue
8. Near intersection of Liberty Road and Milford Hill Road
9. West of I-695 and I-70 intersection.

C. STAC was not able to produce a map using a 500-meter radius at the county level for the burglary data. This radius was too small for the specified boundary search area which resulted in an error message.

Southwest Baltimore County

D. STAC creates one hot cluster using a 3,000-meter radius and a minimum of 181 incidents for the southwest portion of the county. See Map 11.

Number of Events In Cluster	Number of Events In Ellipse	Events per One Million Sq. Meters
1974	1761	9.331

This cluster centered on I-695 from Franklin Blvd to the intersection of I-195 and I-95.

E. Three hot clusters were found using the 1,000 meter burglary parameters. See Map 12.

Cluster Number	Number of Events In Cluster	Number of Events In Ellipse	Events per One Million Sq. Meters
1	571	582	14.854
2	305	300	20.715
3	68	62	23.309

Ellipse 1 centered along I-695 from I-795 to I-70. The second ellipse is centered along I-695 and runs in southwest/northeast direction. Ellipse 3 is located at the southwest corner of Baltimore National Pike and N. Rolling Road.

F. Twelve hot clusters were found by STAC using the 500 meter burglary parameters. See Map 13.

Cluster Number	Number of Events In Cluster	Number of Events In Ellipse	Events per One Million Sq. Meters
1	95	92	37.745
2	67	60	38.103
3	65	59	31.933
4	54	44	46.460
5	34	28	54.335
6	32	32	60.893
7	29	29	62.282
8	29	26	39.263
9	28	25	42.937
10	28	27	57.527
11	27	23	47.919
12	25	23	40.099

The hot spots identified by STAC are located as follows:

1. Along Liberty Road between Courtleigh Drive and Washington Avenue.
2. Centers along the intersection of Windsor Mill Road and Woodlawn.
3. Northeast corner of area formed by N. Rolling Road and I-70.
4. Along Liberty Road between Essex Road and Patterson Avenue.
5. Along N. Rolling Road, north of Dogwood Road.
6. Along Liberty Road between Brenbrook Drive and Old Court Road.
7. Along Frederick Road where I-695 intersections Bloomsbury
8. East of intersection of St. Agnes Lane and Baltimore National Pike (Rt. 40 W)
9. Centers along Old Frederick Road between Rockwell Avenue and Devere Avenue.
10. Centers along Frederick Road from county border to Paradise.
11. Near Reisterstown Road and Milford Mill Road intersection.
12. Along Liberty Road at Offutt Road intersection.

STREET ROBBERY DATA

Street robberies had the following average number of points enclosed in the radii based on a random sample of five points located throughout the county. See Table 2.

Table 2
Average number of robbery incidents
(N=6,219)

	Radius	Average # of Incidents
a.	3,000 meters	45
b.	1,000 meters	6
c.	500 meters	1 *

* Minimum required by STAC is 2

"Pin" Map

Like the residential burglary data, it appears that hot spot areas are hovering around the county/city border. The spoke pattern emerges again, this time the concentrations occur on Liberty Road, Reisterstown Road, York Road, Belair Road, and Eastern Blvd. See Maps 5 and 14.

Graduated Circle Map

There appear to be seven clusters using the graduated circle method. See Maps 6 and 15. The number of incidents at one location range from one to eight.

Again, moving in a clockwise direction from the southwest portion of the county:

1. Holling Ferry and Third Avenue
2. Area bounded by Security Blvd on the North/Southwest; N. Rolling Road on the west; Baltimore on the south and the county line to the east.
3. Along Liberty Road from the County Boundary to Geers Lane.
4. Area bounded by York Road to the North; County boundary to the south; I-695 to the north and Perring Parkway to the east.
5. Area around intersection of I-95 and the county border.
6. Area bounded by Eastern Blvd (north), Holabird Avenue (south), Merritt Blvd (east), and the county boundary (west)
7. Area bounded by Eastern Blvd (north), Martin Road (west), Back River Neck Road (east) and Middleborough Road (south).

Baltimore County

A. Two hot clusters were produced using the 3,000 meter radius criteria. See Map 7.

Cluster Number	Number of Events In Cluster	Number of Events In Ellipse	Events per One Million Sq. Meters
1	593	576	2.047
2	437	365	3.389

Both areas are centered along the Beltway on each side of the county.

B. Nine hot clusters were produced using the 1000 meter criteria. See Map 8.

Cluster Number	Number of Events In Cluster	Number of Events In Ellipse	Events per One Million Sq. Meters
1	109	91	14.365
2	99	97	9.710
3	68	68	10.419
4	63	55	14.626
5	45	36	12.464
6	43	32	12.033
7	40	36	19.685
8	30	25	15.605
9	27	23	12.382

STAC identified nine hot spot area locations:

1. Intersection of Eastern Blvd and Back River Neck Road
2. Around intersection of I-695 and Baltimore National
3. Centered along Loch Raven Blvd between I-695 and the county border.
4. Along Liberty Road from west of I-695 to west of Brenbrook Road
5. Centered Along York Road from Bosley to west of Stevenson Lane
6. Along Liberty Road from I-695 to Patterson Avenue
7. Along Dundalk Avenue and Delvale Avenue - west of Merritt Avenue
8. South of intersection of Stevenson Lane and York Road
9. Along Baltimore Washington Parkway from I-895 to county border.

Seven of the nine areas were within the Beltway.

C. STAC would not calculate hot clusters using the 500-meter radius at the county level for the robbery data. This radius was too small for the specified boundary search area and resulted in an error message.

Southwest Baltimore County

Graduated Circle Maps

Map 15 shows the same data as Map 6 at a greater level of detail for the southwestern portion of Baltimore County. Four clusters appear to emerge at the following locations:

1. Along Liberty Road from the city/county border out to Brenbrook Drive.
2. Around the cloverleaf formed by I-70 and I-695 - in the NW and SE quadrants.
3. Along Baltimore National Pike from the city/county border to N. Rolling Road.
4. Along I-895 in the area between Hammonds Ferry Road and Annapolis Road.

D. One hot cluster was identified using the 3,000-meter radius parameter. See Map 16.

Number of Events In Cluster	Number of Events In Ellipse	Events per One Million Sq. Meters
487	444	2.521

One large cluster appears along I-795/I-695 from Owings Mill Blvd to I-95.

E. One large and three small hot clusters were found using the 1,000 meter criteria. See Map 17. It is interesting to note that the large cluster partial overlaps a smaller cluster and completely encompasses another. Data calculated by STAC for these fields are not correct because overlapping circles were produced.

The locations of the clusters are as follows:

1. Centers along I-695 from the intersection of I-695 and I-795 to Frederick Road.
2. Along N. Rolling Blvd. From Security Blvd. To I-70.
3. Intersection of Reisterstown Road and Old Court Road.
4. Intersection of Wilkens Avenue and Maiden Choice Lane.

F. Nine hot clusters were found in southwest Baltimore County using the 500-meter radius for robbery incidents. Although in our random sample of number of incidents occurring in a 500-meter radius was one, STAC requires a minimum of two incidents in order to do the calculations for the standard deviational ellipse. Therefore, two was entered as the minimum number of incidents when the program was run. See Map 18.

Cluster Number	Number of Events In Cluster	Number of Events In Ellipse	Events per One Million Sq. Meters
1	48	50	13.933
2	38	33	23.922
3	25	21	17.136
4	25	22	166.077
5	24	22	21.590
6	21	23	18.899
7	14	13	31.007
8	12	11	20.554
9	10	10	22.003

Those hot spot areas are located as follows:

1. Centered at intersection of Baltimore National Pike and Academy Road.
2. Along Liberty Road at Old Court Road
3. Along Liberty Road at New Milford Mill Road
4. Along Liberty Road between Essex Road and St. Lukes Lane
5. Centered along N. Rolling Road between I-70 and Security Blvd.
6. Centered along Baltimore National Pike roughly between N. Rolling Road and I-695.
7. Located in the southeast quadrant formed by I-70 and I-695.
8. Located in the northeast quadrant formed by I-70 and I-695; at the intersection of Woodlawn Road and Security Blvd.
9. Centered at intersection of Maiden Choice Lane and Wilkens Avenue.

Practical Utility of STAC

STAC is not a mapping package, it must be used in connection with a GIS package to map visible "hot spot" areas. It is most easily used, as mentioned earlier, with MapInfo since the data produced by STAC is readily importable to the package.

Since some front end editing must be done to STAC program files before reading in data for incidents in a particular area, it may be more easily used by someone working in a fixed location - an area whose boundaries do not change. For example, STAC would be especially easy to use in a particular municipal or county police/sheriff agency where a one time set up of the search boundary would be required. Other than the initial modification of files, STAC is very easy to use. It would also be well suited for researchers - those whose areas of study change - with the noted caveat.

In addition to producing the hot spot area ellipses the data can also be run with the accompanying Nearest Neighbor Analysis (NNA) to determine if the incidents are a result of non-random clustering. A report is produced for the NNA.

Trends in hot spots can be viewed by adding subsequent ellipses to a map over time using the processes described above. The only way that trends can be analyzed using STAC is to run the program for each period the user wishes to observe, saving each series of output under a different name and then importing the STAC output into the users mapping package. Multiple layers will then display any changes in hot spot area locations.

Limitations

The program was very easy to use after getting past the initial set up process. We believe that STAC may be more difficult to use for those users who started using computers in the Windows age. The DOS editing and data screening are not as simple as point and click. Which leads us to our recommendation: Make STAC a Windows-based product.

The conversion of the coordinates from LL to UTM and back seems confusing. The program user must also realize that meters are the unit of measurement when specifying search radii. This is not a problem, however, if the using state plane or any other flat grid, the unit can be feet.

STAC only allows for a rectangular or square search area boundary. This could be improved by allowing for a polygonal area to be used to define the boundary to more closely approximate actual geographic limits.

The best aspect of STAC to most users will be the fact that it is free. The user network also allows users to interface with one another for technical support purposes and for further understanding of hot spot area applications.

REFERENCE

State of Illinois, Illinois Criminal Justice Information Authority (ICJIA). SPACE Analyzer User's Manual. ICJIA: Chicago, IL (1996).

State of Illinois, Illinois Criminal Justice Information Authority (ICJIA). TIME Analyzer User's Manual. ICJIA: Chicago, IL (1988).

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APPENDICES

MAPS PRODUCED

Map#	Description
SET A	
1	Baltimore County residential burglaries - point map
2	Baltimore County residential burglaries - graduated circles
3	Baltimore County residential burglaries - 3,000 meter radius, triangulated scan, 181 minimum number of incidents.
4	Baltimore County residential burglaries - 1,000 meter radius, triangulated scan, 24 minimum number of incidents.
SET B	
5	Baltimore County street robberies - point map
6	Baltimore County street robberies - graduated circle map
7	Baltimore County street robberies - 3,000 meter radius, triangulated scan, 45 minimum number of incidents.
8	Baltimore County street robberies - 1,000 meter radius, triangulated scan, 6 minimum number of incidents.
SET C	
9	Southwest Baltimore County residential burglaries - point map
10	Southwest Baltimore County residential burglaries - graduated circle map
11	Southwest Baltimore County residential burglaries - 3,000 meter radius, triangulated scan, 181 minimum number of incidents.
12	Southwest Baltimore County residential burglaries - 1,000 meter radius, triangulated scan, 24 minimum number of incidents.
13	Southwest Baltimore County residential burglaries - 500 meter radius, triangulated scan, 5 minimum number of incidents.
SET D	
14	Southwest Baltimore County street robberies - point map
15	Southwest Baltimore County street robberies - graduated circle map
16	Southwest Baltimore County street robberies - 3,000 meter radius, triangulated scan, 45 minimum number of incidents.
17	Southwest Baltimore County street robberies - 1,000 meter radius, triangulated scan, 6 minimum number of incidents.
18	Southwest Baltimore County street robberies - 500 meter radius, triangulated scan, 2 minimum number of incidents.

SAMPLE STAC OUTPUT

C:\STACV4\B_CO1000.FIL
There are three different output files:
One is this report, called REPORTS.FIL. (This file may be printed out using the DOS Edit program's print command. However, be sure to press the form feed key on your printer or it won't eject any page that is less than full.) Two is a text file containing the coordinates of the standard deviational ellipses. Three is an optional output file for mapping in MapInfo.
See below for the file names for this run.

This is the report for Run number: 1

The Space parameters for this run are:
Lower left X-coordinate = 334061.0
Lower left Y-coordinate = 4333860.0
Upper right X-coordinate = 391194.0
Upper right Y-coordinate = 4400572.0
Search radius = 1000.0 meters
Scan Type - - (1) Triangular
Minimum number of incidents in a hot cluster: 24

The input file is BURG.CSV.
There are 6219 incidents in the input file.
This count includes: 6219 records within the specified parameter boundary

9 hot clusters were detected by STAC and you chose 9 hot clusters.
The stats for these 9 hot clusters are:

No. of Events In Cluster	No. of Events In Ellipse	Area of the Ellipse In Sq. Meters	Events per One Million Sq. Meters	Mean Center
356	407	16152002.2	25.198	X=375017.8 Y=432371.6
319	379	21749607.1	17.426	X=355929.5 Y=4345581.1
239	218	6451176.8	33.792	X=369020.5 Y=4347020.2
147	140	5500320.3	25.453	X=351788.0 Y=4350134.4
127	119	4723307.4	25.194	X=364439.8 Y=4359802.9
87	88	3322749.9	26.484	X=371365.8 Y=4348088.0

86	88	2615064.7	33.651	X=361797.6 Y=4362408.7
84	86	2183004.3	39.395	X=348152.0 Y=4357581.6
79	82	3287697.2	24.941	X=347938.8 Y=4352837.0

Number of Events not within an ellipse: 4612

Area outside all ellipses*: 3745471766.1 in sq. meters
Events per 1,000,000 sq. meters outside all ellipses*: 1.2314
* If any ellipses are overlapping, the above figures are incorrect.

This report is REPORTS.FIL.
The text file that contains the coordinates of the ellipse is ELIPSE.OUT.
The text file that contains the coordinates for the mean centers of the ellipses is CENTER.OUT.
B_CO1000.MBI is the mapping file.
All these files are in the current directory.

For MapInfo for DOS users:
We strongly recommend that you use MapInfo's boundary import/export module called BDYIMP if you have the DOS version. Otherwise you won't be able see the lines drawn around the ellipse